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1891 April 17.—*Tethys* e. Misty. Satellite seen occasionally; judged in line between $10^h\ 10^m$ and $10^h\ 20^m$.

Enceladus very difficult owing to mist in air. Judged in line at $11^h\ 55^m$.

1891 April 22.—*Tethys* ps. In line with end of ring between $11^h\ 20^m$ and $11^h\ 30^m$.

1891 May 4.—*Rhea* w. Saw satellite occasionally. Nearly up at $10^h\ 25^m$.

1891 April 23.—*Tethys* fn. Up at $10^h\ 15^m$.

Observations of Occultations of Faint Stars during the Total Eclipse of the Moon on 1891 *November* 15, *made at the Royal Observatory, Cape of Good Hope.*

(*Communicated by David Gill, LL.D., F.R.S., H.M. Astronomer at the Cape of Good Hope.*)

In compliance with the request of Professor Döllen, conveyed by letter, preparations were made for observing the occultations of faint stars by the Moon during its total eclipse on November 15. Professor Döllen's circular, which accompanied his letter, gave the predicted Greenwich mean times of eleven disappearances and eight reappearances which might be observed at the Cape, together with the data for checking the accuracy of the predicted phenomena. These predictions, which had been obtained by a graphical process, were recomputed and found to be correct. The largest available instrument at this Observatory—the 10-inch guiding telescope of the photographic equatoreal—was used by Dr. Gill. The eye end of this instrument is fitted, not with the usual position micrometer, but with an eye-piece mounted on two slides at right angles to each other, by one of which the eye-piece can be displaced from the axis nearly 1° + or − in declination, and by the other to the same amount east or west of the axis. The amount of displacement is read off by finely divided scales. It was thus necessary to provide means for keeping the centre of the Moon coincident with the axis of the telescope, so that the centre of the eye-piece could be set by means of the scales (the proper readings having been previously computed) to the precise point of disappearance, and specially of reappearance of the star at the Moon's limb.

For this purpose an eye-piece of 2 inches focal length was adapted to the cover of the dark slide of the photographic telescope. The field of this eye-piece was about 34 inches in diameter, so that Mr. Woods found no difficulty, with the aid of the slow motions in R.A. and Decl., in keeping the Moon's centre in coincidence with the axis of the telescope during

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the whole period of totality, and thus the phenomena were observed in every case precisely at the expected point.

The sidereal clock of the photographic observatory has a very feeble beat, and as the contingency of a high wind had to be faced (and, in fact, was blowing during the eclipse), the phenomena were observed not by the beat of this clock, but by the beat of a galvanic 'sounder,' actuated by the same relay as that which actuates the chronograph of the transit circle. Half an hour before totality the sidereal clock in the photographic observatory was set to exact coincidence with the beat of the sounder (the sixtieth second being identified by a missing beat), so that the observer had no difficulty in 'picking up the second' from the clock face at any moment. For further certainty the observer repeated aloud the seconds of his count, which was thus controlled by Mr. Power, who acted as clerk, and who recorded the times of observed phenomena dictated by the observer, and immediately afterwards indicated the settings of the scales for the next star. This method of observation left nothing to be desired. All possible errors of comparing clocks were entirely avoided, and the loud sharp beats of the sounder gave a certainty and precision to the observations which one must experience in order to realise. I am convinced that phenomena like occultations can be more accurately observed in this way than by chronographs, as (in the case of reappearances particularly, and specially in those of very faint stars) one sees at the expected point 'something' of which one notes the instant mentally; but it is necessary to wait a sensible time before one is *sure* that the desired phenomenon was observed. This is more particularly the case when (as on November 15) the definition is very bad—the Moon's limb undulating greatly, and the true phenomena of reappearance take place always within the apparent border of the limb. On account of the very unfavourable quality of the definition the lowest power, 120 diameters, had to be employed.

Mr. Finlay observed with the 7-inch Merz equatoreal, which is fitted with a position circle and filar micrometer by Repsold. The position circle and the wires are illuminated by light from a single fixed incandescent electric lamp, so that successive position angles can be pointed with great rapidity. Mr. Finlay has used this instrument for a very long series of observations of comets and occultations, and preferred to adopt his usual habit of employing the beats of a chronometer, which is compared before and after observation with the Transit clock. The lowest power, 120, was used on account of the bad state of the atmospheric conditions.

Mr. Finlay's observations were recorded by Mr. Cochrane.

Mr. Pett observed with the 6-inch Grubb equatoreal, which was fitted with a micrometer by Troughton and Simms, having bars instead of spider lines, which enable the position-angle on the Moon's limb to be accurately pointed without artificial illumination. The micrometer is provided with only two eye-pieces,

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one magnifying 90, the other 230 diameters. Of these Mr. Pett preferred to use the higher power, with which, however, the star images were very diffused, especially so during the latter half of totality.

Mr. Pett's observations were recorded by Mr. Woodgate.

Mr. Cox observed with the heliometer. There are four intersecting metal bars forming a square in the field of view; the centre of this square marks the optical axis. Two sides of the square are parallel to the motion of the slides. One of the other wires (at right angles to the motion of the slide) was used to cut off the required segment of the Moon's limb. This wire is identified by its parallelism to a micrometer screw in the eye-piece, which has special functions that need not here be referred to. By simply setting the position-circle of the heliometer to the required position-angle, the observer was enabled to find with certainty the required point of the Moon's limb. The optical centres of the segments of the object-glass were very carefully adjusted to exact coincidence, so that the instrument was practically used as an ordinary telescope of $7\frac{1}{2}$ inches aperture, with the exception that the telescope itself was revolved about its axis instead of the micrometer only being so. Mr. Cox employed an eye-piece magnifying 155 diameters; his observations were recorded by the beats of a sounder, the same being actuated by the Transit clock relay in the same manner as in Dr. Gill's observations, Mr. Goodman acting as clerk.

The relative positions of the various telescopes to the Transit circle and the heights of the object-glasses above sea-level at mean epoch of the eclipse are—

	From Transit Circle.		Height above sea-level.
Photographic Equatoreal	450 feet S.	130 feet E.	57 feet
7-inch Equatoreal	200 „ N.	145 „ W.	45 „
6 „ „	370 „ S.	50 „ E.	59 „
Heliometer	200 „ N.	60 „ E.	55 „

The following Table gives the sidereal times of the various phenomena as determined by the different observers:—

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Star's No.	Mag.	Phenomenon.	Gill.	Finlay.	Pett.	Cox.
			h m s	h m s	h m s	h m s
(42) Probably		D	4 23 46·3 (South of ⁎ No. 40.)	...	...	...
40	10–11		4 27 37·4	4 27 39·4 Not certain.	4 27 37·9 Sharp disappearance.	4 27 37·3
25	9·5	R	4 35 17·3 Bad observation.	Star not seen.	Not seen till clear of limb.	Not seen till too late.
38	10–11	D	...	...	...	...
46	9·5	D	...	Star not seen.	...	...
31	9·0	R	4 40 23·8 Very good; star within limb.	4 40 35·2 Very good; star within moon's limb when first seen. [Note probably miscounted 10 secs. D.G.]	4 40 23·3	...
51	11	D	Lost before reaching limb.	Cloud passing at time.	Lost sight of when nearing limb.	Too faint.
50	11	D	4 57 9·0	Cloud passing at time.	Lost sight of near limb.	Too faint.
34	10–11	R	5 8 19 ±	5 8 16·6	...	...
58	11	D	Too faint.	Star not seen.	...	Too faint.